

# The vascular flora of the lower Sieve Valley (Tuscany, central Italy)

Lorenzo Pinzani<sup>1</sup>

<sup>1</sup> Department of Science, University of Roma Tre, Viale G. Marconi 446, 00146 Rome, Italy

Corresponding author: Lorenzo Pinzani (lorenzo.pinzani@uniroma3.it)

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## Abstract

A comprehensive checklist of vascular flora occurring in the lower Sieve Valley basin (province of Florence, Tuscany) is presented. Despite its economic and agricultural significance, this territory has been largely overlooked by botanists, resulting in a substantial gap in floristic information. The checklist is based on bibliographic analysis and field studies carried out between 2018 and 2024. A total of 1034 spontaneous taxa (species and subspecies), including 141 aliens, are reported for the territory. Of these, 21 taxa represent new records or confirmations for the province of Florence and 893 taxa are new to the lower Sieve Valley. *Tilia americana* L. and *Sequoia sempervirens* (D. Don) Endl. are newly reported for Tuscany and *Populus ×canadensis* Moench nothosubsp. *canadensis* should be considered as a naturalized alien in the region. Life forms and chorotypes exhibit pronounced Eurosiberian affinities, with a significant contribution from Mediterranean plants. This pattern aligns with the temperate and continental climate of the area, which is partially influenced by summer aridity.

## Keywords

Alien species, biodiversity, endemics, floristic data, Italy, phytogeography, Tuscany

## Introduction

Quantifying biodiversity is a primary objective for the scientific community, with plant diversity being of fundamental importance for achieving this goal (Kier et al. 2005). Floristic research serves as a foundation for biodiversity conservation efforts, and comprehensive floristic knowledge of a territory is essential for numerous applications in plant science (Peruzzi 2018). Unfortunately, these time-demanding activities

are in decline, despite their crucial role in understanding and preserving our natural heritage (Prather et al. 2004). In floristic research, it is highly advisable to formulate an initial hypothesis regarding the expected number of taxa in a study area to guide field activities and contextualize the results obtained. To this end, Species-Area Relationships (SARs) serve as an excellent tool (D'Antraccoli et al. 2019, 2024).

The lower Sieve Valley (Tuscany, central Italy; Fig. 1) connects relevant areas of Tuscany: the Florentine Hills to the west, Mugello to the north, Casentino to the east, and Valdarno to the south. This strategic location enhances its significance fostering economic and cultural interactions among these diverse geographical areas. Additionally, this region is of remarkable viticultural importance, encompassing one of the seven subzones of Chianti Classico DOCG production, known as “Chianti Rufina” (D. Inter. July 31, 1932).

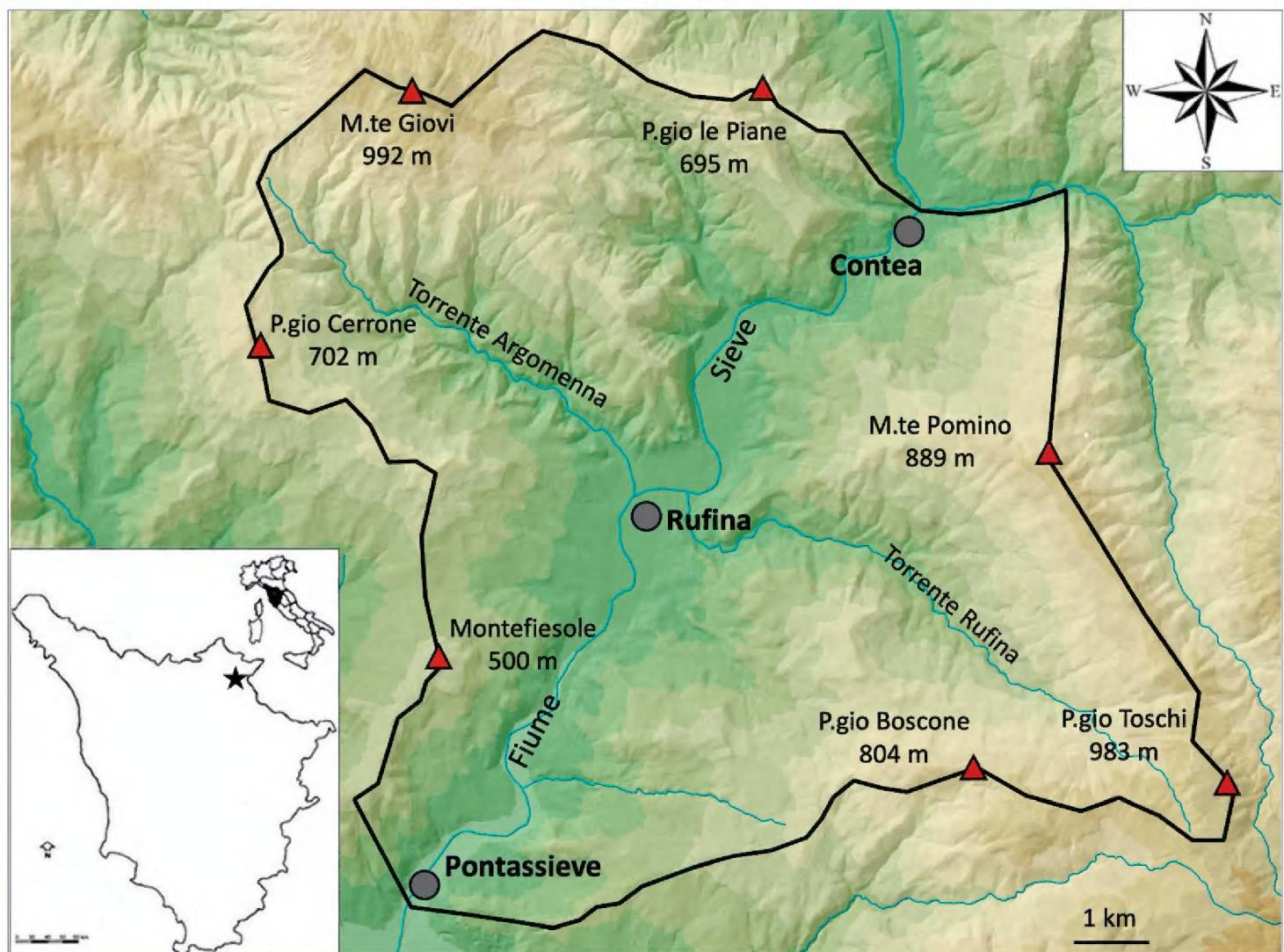
Despite its proximity to the city of Florence and the intense floristic research concentrated in this province over the past two decades (Ferroni et al. 2004; Viciani et al. 2008; Gestri and Peruzzi 2013; Gei et al. 2016; Selvi et al. 2016; Roma-Marzio et al. 2020; Gestri et al. 2023; Peruzzi 2023), the territory of the lower Val di Sieve has been largely overlooked by botanists over time, resulting in a lack of floristic information.

The first floristic records for the lower Sieve Valley were reported by Caruel (1860) and subsequently supplemented by Baroni (1897–1908). In the last century, Piussi (1962) conducted a silvicultural study, providing some floristic information for the artificial conifer plantations of the area. The most significant contribution is a popular botanical guide produced for the municipality of Pontassieve (Sartini and Mantovani 1993), although it was primarily conceived for educational purposes and lacks precise information on the localization of the reported taxa. Few additional floristic information can also be derived from Romolini (2001), Lombardi et al. (2002), Romolini and Sodi (2009) and Arrigoni (2020). Overall, between 1860 and 2010, only 140 taxa can be referred to the lower Sieve Valley, with 70 of them reported before 1950, mainly in studies not focused on extensive floristic exploration of this area.

## Material and methods

### Study area

The study area encompasses a section of the Sieve River basin between Contea and Pontassieve (Fig. 1), ranging from 90 to 992 meters in elevation and covering an area of 101 km<sup>2</sup>. The valley is confined by the Florentine hills to the west side, Mugello valley to the north, Casentino mountains to the east, and Valdarno valley to the south. This territory lies within the province of Florence, spanning parts of the municipalities of Pontassieve, Pelago, Rufina, and Londa. The landscape is diverse and complex, topographically divided into three sectors: the valley floor, the hilly area, and the sub-mountainous zone. The valley floor, developed along the Sieve River, is



**Figure 1.** Localization and delimitation of the lower Sieve Valley (province of Florence, Tuscany). The black line defines the limit of the study area. The different shades of colors identify areas at different elevations ranging from 90 m to 992 m a.s.l. The Sieve River and the main streams are illustrated in blue. The image was obtained by means of Cartoteca del Geoscopio della Regione Toscana (<http://www502.regione.toscana.it/geoscopio/cartoteca.html>).

situated between 90 and approximately 150 meters above sea level. The hilly areas are well-developed at elevations between 150 and 700 meters and the sub-mountainous zone, above 700 meters is represented by the summit of Monte Giovi (992 m) to the northwest and the ridge from Monte Pomino (889 m) to Poggio Toschi (983 m) and Poggio Boscone (803 m) from the east to the southeast.

### The main land uses in the area can be summarized as follows

Areas of high anthropogenic influence mainly concentrated in the valley floor (urbanized and industrial zones, transport infrastructure); agricultural areas (croplands, vineyards, olive groves, orchards) covering much of the territory from the valley floor to the hills; non-productive open areas (meadows, pastures, and fallow lands) distributed throughout the territory; forested areas (artificial conifer plantations, broadleaf-dominated forests, hygrophilous vegetation) primarily concentrated in the hilly and mountainous zone; open areas with sparse or absent vegetation (mostly rugged and rocky areas)

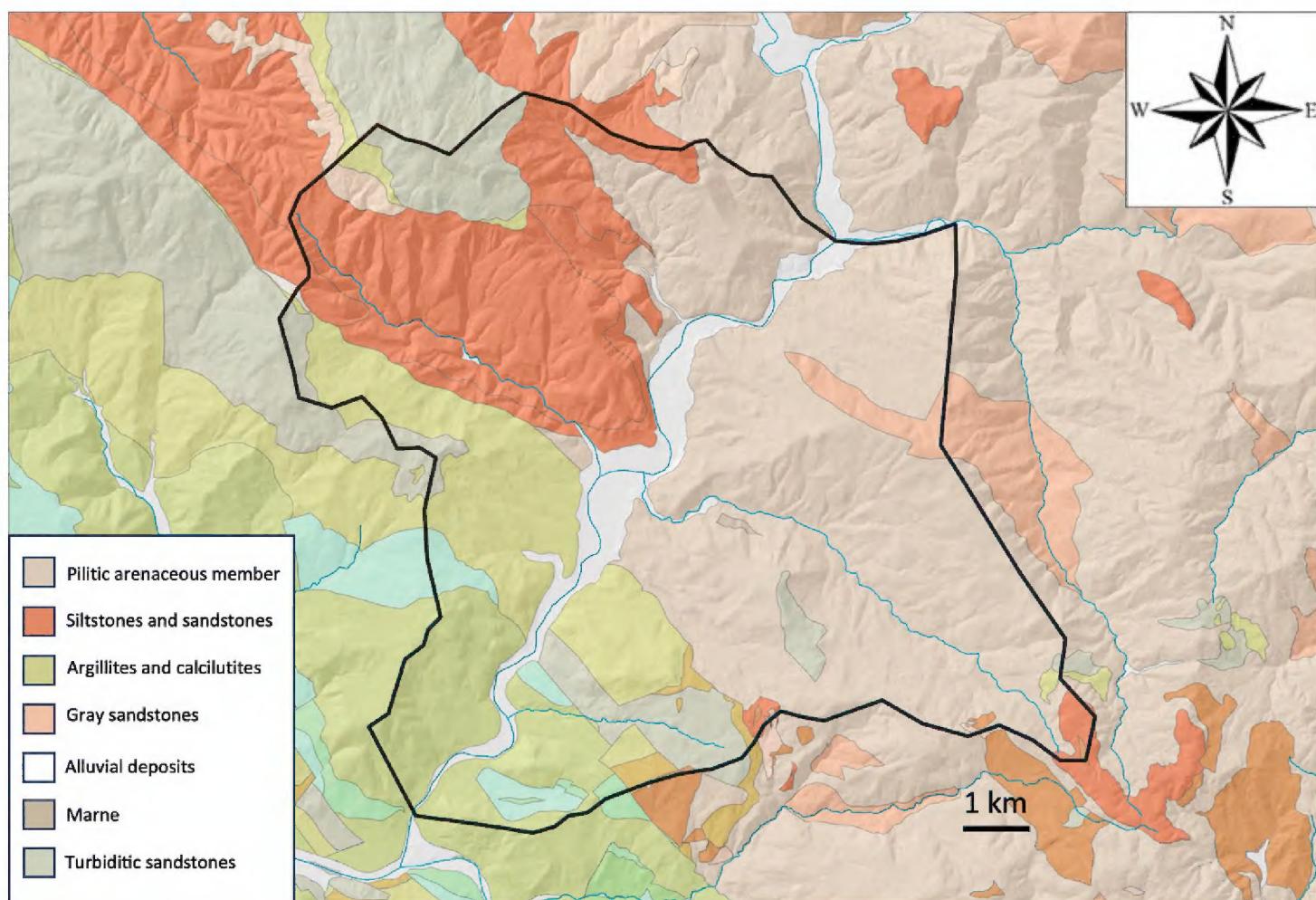
mainly concentrated on top of the reliefs and in particularly steep slopes; water bodies (rivers, streams, artificial reservoirs for irrigation or fishery purposes) distributed throughout the territory.

In the absence of previous specific studies on the vegetation of the lower Sieve Valley, the vegetation landscape can be described following Arrigoni (1998, 1999), and personal observations as follow:

mesophilic woods dominated by *Fagus sylvatica* L. subsp. *sylvatica*; Chestnut groves (*Castanea sativa* Mill.); mesophilic woods variably dominated by *Carpinus betulus* L., *Ostrya carpinifolia* Scop., *Quercus cerris* L., *Quercus pubescens* Willd. subsp. *pubescens*); mixed woods of thermophilic broadleaf; mixed woods of mesophilic broadleaf; woods dominated by *Quercus ilex* L., hygrophilous and riparian tree formations (*Populus* sp. pl., *Salix* sp. pl., *Alnus glutinosa* (L.) Gaertn., *Ulmus minor* Mill. subsp. *minor*); synanthropic formations dominated by *Robinia pseudoacacia* L.; reforestation of conifers (mainly *Cupressus sempervirens* L., *Pseudotsuga menziesii* (Mirb.) Franco, *Pinus* sp. pl.); mixed woods of conifers and broadleaf; mixed woods of conifers and sclerophylls; degraded or recolonizing shrublands on acidic soils (*Cytisus scoparius* (L.) Link subsp. *scoparius*, *Ulex europaeus* L. subsp. *europaeus*, *Erica* sp. pl., *Pteridium aquilinum* (L.) Kuhn subsp. *aquilinum*); degraded or recolonizing shrublands on basic or neutral soils (*Spartium junceum* L., *Prunus spinosa* L. subsp. *spinosa*, *Cornus sanguinea* L. subsp. *hungarica* (Kárpáti) Soó, *Rosa* sp. pl., *Rubus* sp. pl.); secondary xerophilic meadows, dominated by *Brachypodium rupestre* (Host) Roem. & Schult.; perennial mesophilic meadows, pasture meadows, and hay meadows; sparse vegetation of lithosols and eroded areas;

From a geological point of view, the area is characterized by sandstone and marl deposits, with some rare intercalations of argillites and marls, transitioning to recent formations of fluvial deposition or those due to intense slope processes (debris derived from the alteration and/or erosion of materials constituting the hilly and mountainous areas). The presence of different soils also causes variations in the concentration and intensity of erosion, which partially affects the type of vegetation present and agricultural use (Fig. 2).

The climate of the area can be overall classified as temperate-cold with hot and dry summers. For the valley bottom, the nearby village of Remole (Sieci, 58 m a.s.l.) reports an annual average precipitation of 856 mm, peaking in November (125 mm) and reaching its lowest in July (31 mm), while the annual average temperature is 13.7 °C with the coldest month averaging 5.4 °C (Servizio Agrometeorologico dell'ARSIA). For higher areas, Piussi (1962) estimates an annual precipitation of about 1280 mm between 500 m and 750 m, and over 1400 mm between 750 m and 1000 m. For temperatures, the summit portion of Monte Giovi (above 900 m) has an average annual temperature below 10 °C with the coldest month around 0 °C (Piussi 1962). Accordingly, applying Pavari's phytoclimatic classification (Pavari 1916), the valley bottom belongs to the cold subzone of *Lauretum*, the hilly areas to the warm subzone of *Castanetum*, and the mountainous areas above 900 m to the warm subzone of *Fagetum* (Piussi, 1962).



**Figure 2.** Main geological formations in the lower Sieve Valley. The black line defines the limit of the study area. The image was obtained by means of Cartoteca del Geoscopio della Regione Toscana (<http://www502.regione.toscana.it/geoscopio/cartoteca.html>).

## Floristic inventory

In addition to analyzing the limited literature available (see Introduction), field investigations from 2018 to 2024 were carried out. The most noteworthy findings were published during this research period (Peruzzi et al. 2019, 2020, 2021; Bartolucci et al. 2020, 2024a; Musarella et al. 2024). Documentation of taxa was done through collection of herbarium specimens preserved in the personal herbarium of the author (*Herb. Pinzani*) in FI and PI (international code according to Thiers 2020, and onwards) and photographic material, supplemented by additional field observations stored in Wiki-plantase #Toscana (Peruzzi and Bedini 2013 onwards).

The taxa reported in the literature were considered only when clearly referable to the lower Sieve Valley basin. For this reason, the floristic list published by Sartini and Mantovani (1993) was not considered, as it generally referred to the territory of Pontassieve, making it impossible to distinguish taxa occurring within the study area from those in neighboring areas.

Taxonomic nomenclature, circumscription of taxa and regional presence follow Bartolucci et al. (2024b), Galasso et al. (2024), and their periodic updates in the Portal to the Flora of Italy (2024), Martellos et al. (2020). Taxonomic nomenclature of hybrid and cultivated taxa not listed in the cited references follows

World Flora Online (WFO 2024). Regional and provincial presence of woody species follows Roma-Marzio et al. (2016). Angiosperm families are organized according to APG IV (2016). Within each family, genera, species, and subspecies are listed alphabetically. Life forms and chorotypes follow the classifications of Pignatti et al. (2017a, 2017b, 2018). We also noted taxa included in the National Red List (Rossi et al. 2013, 2020), in the Regional Red Lists (Conti 1997), in the annexes of Regional Law No. 56/2000 and in the “Repertorio Naturalistico Toscano” (Sposimo and Castelli 2005). The endemicity status was based on Peruzzi et al. (2014, 2015) and Bartolucci et al. (2024b). The complete dataset compiled for this study is available in Suppl. material 1.

To verify whether the total and alien floristic richness of the study area was higher or lower than expected, we refer to D’Antraccoli et al. (2019), applying the species-area formula specifically developed for Tuscany, accounting for the environmental correction.

## Results

### Floristic inventory

The expected number of species/subspecies and alien taxa was 1,009 and 89, respectively.

A total of 1,034 specific and subspecific taxa occur in the study area, including 109 established aliens (naturalized plus invasive) representing about 10% of the established flora; two are new records for Tuscany, 21 represent new records or confirmations for the province of Florence and 893 are new for the lower Sieve Valley. Regarding taxa recorded before 1950, 33 have been directly confirmed during field surveys whereas 39 taxa reliably recorded in the past were not confirmed. The recorded flora is documented with approximately 900 herbarium specimens, 3,000 photos, and 5,000 field observations. Three families alone account for 30% of the total vascular flora (Asteraceae 131 taxa, Poaceae 93 and Fabaceae 88), although Lamiaceae (47), Brassicaceae (42) and Rosaceae (42) are also well represented. The most represented genera are *Trifolium* (19), *Carex*, *Lathyrus* and *Veronica* (11).

Biological and chorological spectra highlight that hemicryptophytes (35.1%), therophytes (30.1%), and geophytes (15.4%) are the most represented life forms, followed by phanerophytes (11.7%), chamaephytes (3.9%), nano-phanerophytes (2.5%) and hydrophytes (1.2%).

Regarding the chorological spectrum, Eurosiberian (32.6%) and transitional Eurosiberian-Mediterranean (30.3%) and are the most frequent chorotypes, followed by wide distribution (14.3%) and Mediterranean (13.5%). Alien taxa represent 10.9% of the established flora.

The Italian endemics are 12: *Bellevalia webbiana* Parl., *Crocus biflorus* Mill., *Centauraea arrigonii* Greuter, *Daucus broteroi* Ten., *Digitalis micrantha* Roth ex Schweigg., *Erysimum etruscum* Peccenini & Polatschek, *Ophrys appennina* Romolini & Soca, *O. classica* Devillers-Tersch. & Devillers, *Polygala flavescens* DC. subsp. *flavescens*, *P. vulgaris* L. subsp. *valdarnensis* (Fiori) Arrigoni, *Scabiosa uniseta* Savi, and *Sesleria italica* (Pamp.) Ujhelyi.

## Discussion

Relative to the predicted richness based on Species-Area Relationships (SARs), the correspondence between the expected and observed number of established taxa is nearly exact (99.3%). This indicates a high level of floristic diversity in the lower Sieve Valley, comparable to other regions in Tuscany (D'Antraccoli et al. 2019). Alien taxa exceed expectations by 22%. Consequently, the study area has a relatively high number of aliens, albeit proportionally lower than other nearby areas like the Cerbaie Hills (+53%) and the municipality of Empoli (Peruzzi 2023, +207%). Notably, among the aliens, *Ailanthus altissima* (Mill.) Swingle and *Ludwigia peploides* (Kunth) P.H.Raven subsp. *montevidensis* (Spreng.) P.H.Raven are listed under European regulation EU 2019/1262 although the most widespread alien species in the area are *Arundo donax* L. and *Robinia pseudoacacia* L., as evidenced by a recent and extensive monitoring conducted on the Tuscan road network for these species (Pinzani and Ceschin 2023).

Four species recorded in the lower Sieve Valley during this study represent novelties or confirmations at the regional level: *Zannichellia peltata* Bertol. (Bartolucci et al. 2020), *Bolboschoenus planiculmis* (F.Schmidt) T.V.Egorova (Bartolucci et al. 2024a), *Tilia americana* L., and *Sequoia sempervirens* (D.Don) Endl. (original data).

Moreover, 44 taxa, either new or recorded for the province of Florence before 1950, were documented. Of these, 23 have been published by the author in previous floristic contributions, while 21 are presented as new findings within this study.

Based on field research, it is proposed to change the alien status in Tuscany of the nothospecies *Populus ×canadensis* Moench nothosubsp. *canadensis*. This alien is widespread along the terminal stretch of the Sieve River, where it actively competes with the native *Populus nigra* L. subsp. *nigra*. The invasive potential of this alien in riparian environments has been repeatedly observed in other Italian rivers, such as along the Tiber and its tributaries in Lazio, and along the Tirso River in Sardinia (Galasso et al. 2021). On this basis, *P. ×canadensis* in Tuscany should currently be considered a naturalized alien.

Other rare species in Tuscany are: *Allium pallens* L., *Bellevalia webbiana* Parl., *Dactylorhiza insularis* (Sommier) Landwehr, *Dracunculus vulgaris* Schott., *Goodyera repens* (L.) R.Br., *Hordeum bulbosum* L., *Isolepis setacea* (L.) R.Br., *Linaria simplex* (Willd.) Desf., *Nymphaea alba* L., *Ophrys insectifera* L., *Sporobolus schoenoides* (L.) P.M.Peterson, *Spirodela polyrhiza* (L.) Schleid., *Taraxacum olivaceum* Soest, *Tulipa sylvestris* L. and *Zannichellia palustris* L.

The discovery of new populations of *B. webbiana*, a narrowly Italian endemic species, is significant (Astuti et al. 2018a, 2018b; Peruzzi et al. 2020b, Peruzzi et al. 2022). According to Peruzzi and Carta (2011), the Area of Occupancy (AOO) of *B. webbiana* is currently very limited (68 km<sup>2</sup>) and is gradually decreasing (Gestri et al. 2010). These new sites notably expand the known range of this Italian endemic species.

The taxa showing some conservation interests (Rossi et al. 2013, 2020) are 17, 14 of which are categorized as Least Concern, two Data Deficient, two Near Threatened (*Dactylorhiza insularis* and *Zannichellia palustris*), one Vulnerable (*Dracunculus vulgaris*),

and one Endangered (*Bellevalia webbiana*) at national level. Additionally, 10 species are included in the Regional Red Lists (Conti 1997), 83 are listed in the annexes of Regional Law No. 56/2000, and 8 are recorded in the “Repertorio Naturalistico Toscano” (Sposimo and Castelli 2005) (for more details, see Suppl. material 1).

Life forms and chorotypes show marked Eurosiberian affinities in agreement with the temperate and continental climate. Comparing the flora of the lower Sieve Valley with those of surrounding areas, the Sambre river valley (Selvi et al. 2016) and Cintoia valley (Ferroni et al. 2004) show similar proportions of hemicryptophytes, therophytes and geophytes compared to the lower Sieve Valley. The prevalence of hemicryptophytes and, at the same time, a high proportion of annual herbaceous plants, is likely due to the presence of open areas and the climate characterized by marked summer aridity. Similarly, the chorology indicates a codominance of Eurosiberian and transitional Eurosiberian-Mediterranean elements with a significant contribution from Mediterranean entities representing a transitional flora with a marked temperate and continental characters and the penetration of elements of Mediterranean origin.

The lack of confirmation for 30 old records, mainly located in the Monte Giovi area (see Suppl. material 1), could be the result of two concurrent factors: on one hand, the approximate information about the locality of data may have led to the inclusion of taxa occurring outside the study area (the northern slope of the relief belongs to the upper Sieve Valley); on the other hand, the increased forest cover due to the abandonment of agricultural land, coupled with extensive reforestation at the summit of Monte Giovi (Piussi 1962), may have resulted in a reduction of habitats suitable for these species.

The environments within the study area that host the most significant species are olive groves (*Bellevalia webbiana*, *Dracunculus vulgaris*, *Tulipa sylvestris*), fallow grasslands on soils of different water content (*Allium pallens*, *Linaria simplex*, *Sporobolus schoenoides*, *Taraxacum olivaceum*), riparian areas (*Zannichellia palustris*, *Z. peltata*, *Bolboschenus planiculmis*, *Leucojum vernum*), and artificial water basins (*Isolepis setacea*, *Nymphaea alba*, *Ranunculus trichophyllum* Chaix, *Zannichellia palustris*). Conversely, the environments hosting the highest number of alien species are urban and riparian areas.

The most impacted habitats within the territory are water bodies (rivers, artificial basins) due to anthropogenic disturbances (hydro-morphological alterations, water over-exploitation, water pollution) and the invasion of alien species. Indeed, aliens are generally favored by disturbed and unstable environmental conditions (Lazzaro et al. 2020; Dimitrakopoulos et al. 2022). These data highlight both the significance and fragility of wetlands and artificial waterbodies for the conservation of rare hygrophilous taxa (Chester 2013), as already observed for other areas in Tuscany (Bonari et al. 2021). Notably, about 50% of Italy's critically endangered species are hydrophytes (Rossi et al. 2013, 2020).

Finally, the widespread presence of aliens along the road network of the lower Sieve Valley and the recent arrival of the alien macrophyte *Ludwigia peploides* subsp. *montevidensis*, poses a serious threat to the integrity of the valley's natural ecosystems. This is particularly relevant for the aquatic habitats, where *L. peploides* demonstrates a remarkable competitive ability with the native communities (Dandelot et al. 2008).

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## Supplementary material I

### Floristic list and records

Authors: Lorenzo Pinzani

Data type: pdf

Explanation note: 1. Floristic list and records. 2. References cited only in the supplementary materials.

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